Plant Archives Vol. 25, No. 2, 2025 pp. 1505-1510 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.217

EVALUATION OF F_3 PROGENIES OF CHINA ASTER HYBRIDS FOR FLOWER QUALITY AND SEED YIELD

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(Date of Receiving-12-07-2025; Date of Acceptance-25-09-2025)

ABSTRACT

The ornamental plant market demands continuous improvement in floral traits to meet commercial needs. In India, China aster cultivars often have semi-double flowers, short stalks, and limited vase life, creating scope for genetic enhancement. To address this, the present study was conducted at the Floriculture Unit, UAS, Bengaluru during *Kharif* 2024, where 27 hybrids developed through Line × Tester design were evaluated for genetic variability, agronomic performance, and flower quality traits using RCBD with three replications.

The results of the present investigation revealed significant variability among the Ff generation hybrids of China aster with respect to flower quality and seed parameters, indicating ample scope for genetic improvement. Superior hybrids such as hybrid-10 and hybrid-9 for flower diameter, hybrid-1 and hybrid-2 for stalk length, and hybrid-5 for vase and shelf life demonstrated promising potential for enhancing ornamental and post-harvest qualities. Similarly, hybrids like hybrid-10 for early seed maturity, hybrid-7 and hybrid-3 for seed yield, and hybrid-7 and hybrid-8 for seed germination emerged as valuable genetic resources for improving seed-related traits. The predominance of additive gene action in most seed parameters suggests the effectiveness of direct selection in advanced generations, while non-additive variance in some flower traits indicates the utility of hybrid breeding strategies. Overall, the identification of superior-performing hybrids offers dual benefits of commercial exploitation and use as parental material in future breeding programmes aimed at developing high-yielding and quality cultivars of China aster.

***Key words*: China aster, Hybrids, Flower diameter, Stalk length, Shelf life, Vase life, Seeds**

Introduction

Flowers have been an integral part of human civilization since ancient times, with floriculture evolving into a rapidly expanding sector of horticulture. Beyond their ornamental appeal, flowers carry substantial social and economic importance by generating year-round employment and contributing to foreign exchange earnings. Rising demand, fuelled by changing lifestyles, urbanization, and corporate culture, has established floriculture as a vital commercial branch of horticulture. Furthermore, economic liberalization and government support have encouraged Indian entrepreneurs to invest in this sector. Among the traditional flower crops grown for loose and cut flower purposes, China aster has become increasingly popular among small and marginal farmers in India owing to its ease of cultivation (Singh, 2006).

China aster (*Callistephus chinensis* Nees.), a commercially important member of the Asteraceae family, is a diploid species (2n = 18) native to China. The genus name *Callistephus* derives from the Greek words *Kalistos* ("most beautiful") and *Stephus* ("crown/flower head"). Initially classified as *Aster chinensis* by Linnaeus, it was later renamed *Callistephus chinensis* by Nees (Janakiram, 2006). Introduced to Europe and tropical regions during the 18th century, it subsequently gained global recognition (Bailey, 1963). The annual plant exhibits hispid, hairy branches with erect, semi-erect, or spreading growth habits. Its leaves are broadly ovate or triangular-ovate with deep serrations. Based on height, plants are grouped as dwarf (20–40 cm), medium (40–60 cm), or tall (>60 cm). The flower heads (capitula) are solitary and consist of outer pistillate ray florets and inner hermaphroditic disc florets.

Strube (1965) reported that doubleness in flowers depends on the ratio of ray to disc florets. The species follows a geitonogamous self-pollination system because of protandry: pollen is released before the stigma unfurls. Residual pollen within the capitulum facilitates self-fertilization, making the crop largely self-pollinated.

China aster performs well under open-field cultivation, ensuring continuous flower supply during both kharif and rabi seasons. Its wide color range and long vase life make it highly suitable for garlands, bouquets, floral decorations, and exhibitions. Dwarf branching types are especially valued for landscaping, herbaceous borders, and bedding (Munikrishnappa *et al.*, 2013). Globally, it is cultivated as a garden and cut-flower crop in Russia, Japan, North America, Switzerland, and Europe. In India, small and marginal farmers predominantly grow it in Tamil Nadu, Karnataka, Maharashtra, Andhra Pradesh, and West Bengal. Karnataka is the leading producer, with major growing regions in Bangalore, Tumkur, Kolar, Chikkaballapur, and Belagavi. The state covers 207 hectares, producing 1,448 metric tons with a productivity of 7.01 t/ha and generating annual revenue of ₹ 430 lakhs (Anon., 2022–23). Flower yield is strongly influenced by season and cultural practices.

Systematic breeding of China aster in India began in the 1990s under the efforts of Negi and Raghava. The Indian Institute of Horticultural Research (IIHR), Bengaluru, and the Ganesh Khind Botanical Garden, Pune, have significantly contributed to variety development. Prominent IIHR cultivars include Arka Poornima, Arka Kamini, Arka Shashank, Arka Adya, Arka Archana, Arka Advika, Arka Nirali, Arka Shubhi, and Violet Cushion. MPKV, Rahuri, released the Phule Ganesh series (White, Pink, Violet, and Purple), while UHS, Bagalkot, introduced Krishnaprabha Chinmay.

The ornamental plant sector is highly dynamic, demanding continuous improvement in varieties. Current Indian cultivars generally bear semi-double flowers with large discs, short stalks, and relatively low vase life. Hence, breeding programs emphasize enhancing plant stature, branching, flower yield, color range, stalk length, and vase longevity for both cut and loose flower markets. Successful improvement depends on exploiting genetic variability, which encompasses both additive (heritable) and non-additive (dominance and epistasis) components. Selection efficiency is better understood through genetic parameters such as phenotypic and genotypic coefficients of variation, heritability, and genetic advance. Considering this, the present experiment was undertaken to evaluate genetic variability in newly developed China aster hybrids by assessing their agronomic traits and flower quality attributes.

Material and Methods

The study was carried out at the Floriculture Unit, Department of Horticulture, University of Agricultural Sciences, GKVK Campus, Bengaluru, during the *Kharif* season of 2024. A total of 27 hybrids were developed using the Line × Tester breeding method and evaluated for genetic variability, agronomic performance and Flower quality. Based on superior performance, 10 of these hybrids were selected for the next generations (F & F_3) and further assessed for flower quality and Seed yield parameters alongside a standard check variety.

The experiment was conducted using a randomized complete block design (RCBD) with three replications and 11 treatments. The details of the genotypes used in the study are as follows:

S. No.	Hybrid	Cross combination (Parentage)
1	Hybrid 1	Arka Poornima × P. G. Purple
2	Hybrid 2	P. G. Pink × Arka Kamini
3	Hybrid 3	P. G. Pink × A.A.C - 1
4	Hybrid 4	Arka Poornima × A.A.C - 1
5	Hybrid 5	P. G. Pink × P. G. Purple
6	Hybrid 6	P. G. White × P. G. Purple
7	Hybrid 7	Miraj Local × A.A.C - 1
8	Hybrid 8	P. G. White × A.A.C - 1
9	Hybrid 9	Miraj local × P. G. Purple
10	Hybrid 10	Arka Poornima × Arka Kamini
11	Check variety	Arka Kamini

Observations recorded

Flower Diameter:

The flower diameter (cm) was measured at the widest part of the bloom using vernier calipers. The average of five randomly selected flowers was recorded and expressed in centimetres.

Stalk length:

The stalk length (cm) was determined by measuring the distance from the bottom cut end of the stalk to the topmost bud of the bloom. The average of five randomly selected plants per treatment was recorded and expressed in centimetres.

Shelf life:

The shelf life (days) was assessed by placing freshly harvested flowers at ambient temperature and observing them for the loss of freshness. The duration taken for the flowers to completely lose freshness was recorded and expressed in days.

Vase life:

The vase life (days) was evaluated by placing China aster blooms with stalks in a vase containing a 2.5% sucrose solution at room temperature. The flowers were observed for signs of freshness loss, including loss of turgidity and rolling of florets. The duration until complete freshness loss was recorded and expressed in days.

Days taken for Seed Maturity:

Number of days from the date of anthesis to the day on which the seeds matured were counted and recorded.

Number of Seeds per Flower Head:

Number of seeds per flower head was counted from selected flower head and average was computed.

Seed Weight per Flower Head:

Seed weight per flower head was counted from selected flower head and average was expressed in grams.

Seed Yield per plant:

From each selected plant, seeds were harvested, cleaned, dried and weighed in grams.

Germination Percentage:

Germination percentage was computed by dividing the number of seeds germinated by the total seeds sown in particular variety and expressed in percentage.

$$\text{Germination (\%)} = \frac{\text{No. of seeds germinated}}{\text{No. of seeds sown}} \times 100$$

Plate 1: Stalk length of F_3 progenies of China aster hybrids.

Table 1: Mean performance of China aster hybrids for flower quality parameters in F_3 generation.

	Parentage	FQP	
		FD	SL
H1	Arka Poornima × P. G. Purple	6.900	67.333
H2	P. G. Pink × Arka Kamini	6.533	57.333
H3	P. G. Pink × A.A.C - 1	6.433	53.167
H4	Arka Poornima × A.A.C - 1	6.033	47.933
H5	P. G. Pink × P. G. Purple	6.167	52.500
H6	P. G. White × P. G. Purple	5.533	55.400
H7	Miraj Local × A.A.C - 1	6.733	46.433
H8	P. G. White × A.A.C - 1	6.333	44.167
H9	Miraj local × P. G. Purple	7.333	46.167
H10	Arka Poornima × Arka Kamini	7.433	51.900
Check	Arka Kamini	5.067	42.233
F-test		**	**
C.D. @ 1%		0.152	1.53
SE(m)		0.051	0.515
SE(d)		0.072	0.728
C.V.		1.383	1.738

FD: Flower diameter (cm); **SL:** Stalk length (cm)
FQP: Flower quality parameters; **Significance at 1% level

Statistical Analysis

The experimental data obtained were subjected to statistical analysis adopting Fishers method of Analysis of variance as outlined by Gomez and Gomez, (1984). The level of significance used in "F-test" was given at 1 %level of significance, wherever "F-test" was significant at 1 % level.

Results and Discussion

Flower Quality parameters

Flower Diameter (cm):

The observations on flower diameter of various China aster hybrids in the F_3 generation are presented in Table 1. Among the hybrids, hybrid-10 (*Arka Poornima × Arka Kamini*) exhibited the maximum flower diameter (7.433 cm), which was statistically at par with hybrid-9 (*Miraj Local × P.G. Purple*) recording 7.333 cm. Conversely, the minimum flower diameter (5.067 cm) was observed

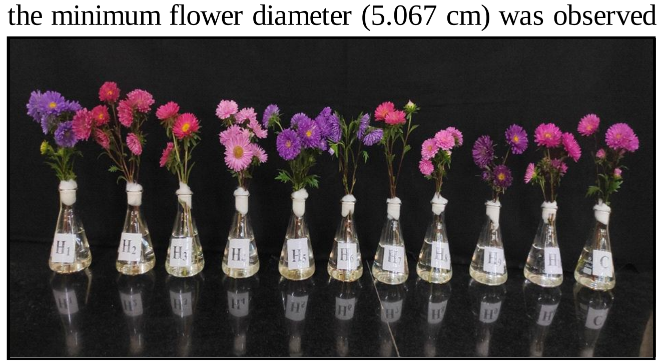

Plate 2: Vase life study of F_3 progenies of China aster hybrids with 2.0% Sucrose solution

in the check variety *Arka Kamini*.

Flower diameter shows variability among hybrids, these hybrids can serve as potential parental material in breeding programs aimed at enhancing flower size, whereas improvement in other hybrids may require exploitation of non-additive variance through recurrent selection or hybrid breeding approaches. Similar results were reported by the Harishkumar *et al.*, (2017) and Nataraj *et al.*, (2021) in China aster.

Stalk Length (cm):

Significant differences were observed for flower stalk length among the F_3 generation hybrids, as presented in Table 1. Hybrid-1 (*Arka Poornima* × *P.G. Purple*) recorded the longest stalk length (67.333 cm), followed by hybrid-2 (*P.G. Pink* × *Arka Kamini*) with 57.333 cm. In contrast, the check variety *Arka Kamini* exhibited the shortest stalk length (42.233 cm). These findings suggest that hybrids-1, 2, and 7 possess greater genetic potential for enhancing stalk length and could be effectively exploited in future breeding programmes. These findings align with the results reported by Henny *et al.*, (2021) in chrysanthemum and Ramya *et al.*, (2019) in China aster, emphasizing the influence of genetic and environmental factors on stalk elongation.

Vase life and Shelf life (Days):

Post-harvest longevity of cut flowers was assessed using 2.0% sucrose solution, and the results indicated significant differences among the hybrids for vase life (Fig. 1). Hybrid-5 (*P.G. Pink* × *P.G. Purple*) exhibited the longest vase life (12.54 days), followed by hybrid-7 (*Miraj Local* × *A.A.C-1*) and hybrid-4 (*Arka Poornima* × *A.A.C-1*) with 12.20 and 11.97 days, respectively. In contrast, the check variety *Arka Kamini* recorded the shortest vase life (8.89 days).

Similarly, the post-harvest shelf life of loose flowers was evaluated under ambient conditions (room temperature), and significant variation was observed among the hybrids (Fig. 3). Hybrid-5 (*P.G. Pink* × *P.G. Purple*) again recorded the maximum shelf life (5.93 days), closely followed by hybrid-7 (*Miraj Local* × *A.A.C-1*) and hybrid-4 (*Arka Poornima* × *A.A.C-1*) with 5.89 and 5.80 days, respectively. Conversely, the shortest shelf life (3.99 days) was observed in the check variety *Arka Kamini*.

The findings highlight the scope for direct selection to improve post-harvest longevity in China aster hybrids. The superior-performing hybrids identified in the study not only possess potential for commercialization but also represent valuable genetic resources for future breeding programmes aimed at enhancing post-harvest quality traits. These findings are in agreement with the results of Ramya *et al.*, (2019) and Nataraj *et al.*, (2021) in China aster and Vishnupriy *et al.*, (2015) in marigold, highlighting the genetic influence on flower longevity and the potential for further improvement through breeding programs.

Seed Parameters

Days taken for Seed maturity:

The number of days required for seed maturity was recorded from the date of anthesis and pollination, and the results revealed significant variation among the hybrids (Fig 2). The check variety *Arka Kamini* exhibited the minimum duration for seed maturity (39.475 days). Among the hybrids, hybrid-10 (*Arka Poornima* × *Arka Kamini*) showed the earliest seed maturity (41.522 days), whereas hybrid-5 (*P.G. Pink* × *P.G. Purple*) required the maximum duration (50.452 days) for seed maturity.

The variability recorded for seed maturity duration among the hybrids suggests considerable scope for genetic improvement. Early-maturing hybrids such as Hybrid-10 provide practical advantages for commercial seed production by reducing crop duration and enabling quicker turnover. Conversely, late-maturing hybrids may prove valuable in breeding programmes aimed at improving seed quality traits through an extended reproductive phase. These findings are in close agreement

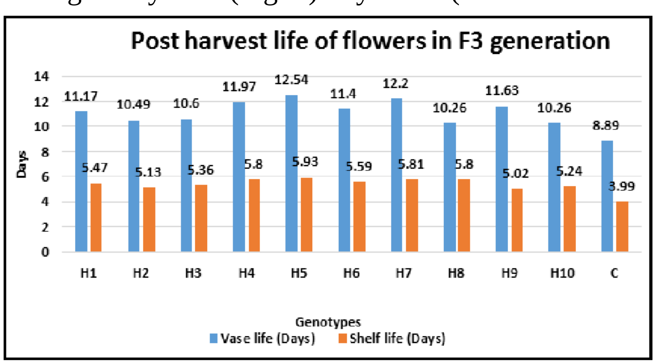

Fig. 1: Mean performance of China aster hybrids for post-harvest longevity of flowers in F_3 generation.

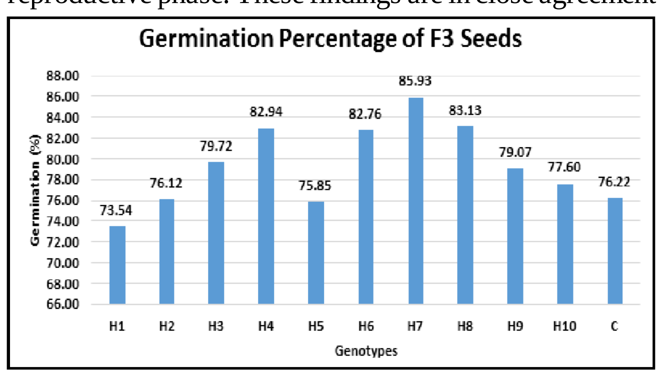

Fig. 3: Mean performance of China aster hybrids for germination percentage of seeds in F_3 generation.

with the earlier reports of Harishkumar *et al.,* (2017), and Nataraj *et al.,* (2021) in China aster.

Number of Seeds per Flower Head:

The F_3 progenies of the hybrids exhibited significant variability for the number of seeds per flower head (Table 2). Among the hybrids, hybrid-7 (*Miraj Local × A.A.C-1*) produced the maximum number of seeds per flower head (62.888), followed by hybrid-3 (*P.G. Pink × A.A.C-1*) with 60.145 seeds. In contrast, the minimum number of seeds per flower head (42.640) was recorded in hybrid-2 (*P.G. Pink × Arka Kamini*).

These results emphasize that the number of seeds per flower head is predominantly under genetic control and is a heritable trait, making it highly amenable for exploitation in selection-based breeding programmes targeting seed yield improvement in China aster. The present findings are in line with the observations of Hallikeri (2018) and Nataraj *et al.*, (2021) in China aster, as well as Patel *et al.,* (2019) in marigold.

Seed weight per flower head and Seed yield per plant: Seed yield parameters of the hybrids in the F_3 generation were assessed and are presented in Table 2. Among the hybrids, hybrid-7 (*Miraj Local × A.A.C-1*) recorded the highest seed yield with 0.468 g seed weight per flower head and 7.858 g seed yield per plant, followed by hybrid-3 (*P.G. Pink × A.A.C-1*), which produced 0.442 g per flower head and 7.573 g per plant. In contrast, the lowest seed yield was observed in hybrid-2 (*P.G. Pink × Arka Kamini*), with 0.299 g per flower head and 5.669 g per plant.

These findings indicate that seed yield traits in China aster are predominantly heritable, largely governed by additive gene action, and therefore responsive to direct selection. This highlights their suitability for targeted genetic improvement strategies aimed at enhancing seed productivity in advanced generations. The present results

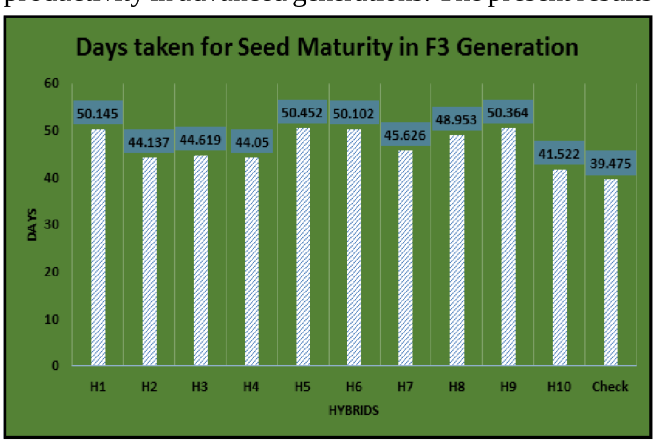

Fig. 4: Mean performance of China aster hybrids for Days taken for seed maturity in F_3 generation.

Table 2: Mean performance of China aster hybrids for flower quality parameters in F_3 generation.

	Parentage	SP		
		NH	SH	SW
H1	Arka Poornima × P. G. Purple	45.174	0.312	6.129
H2	P. G. Pink × Arka Kamini	42.640	0.299	5.669
H3	P. G. Pink × A.A.C - 1	60.145	0.442	7.573
H4	Arka Poornima × A.A.C - 1	53.933	0.429	7.464
H5	P. G. Pink × P. G. Purple	49.723	0.364	7.146
H6	P. G. White × P. G. Purple	52.023	0.403	7.343
H7	Miraj Local × A.A.C - 1	62.888	0.468	7.858
H8	P. G. White × A.A.C - 1	51.152	0.403	7.332
H9	Miraj local × P. G. Purple	43.952	0.325	6.052
H10	Arka Poornima×Arka Kamini	46.539	0.325	6.271
Check	Arka Kamini	47.344	0.364	5.439
F-test		**	**	**
C.D. @ 1%		1.388	0.012	0.183
SE(m)		0.467	0.004	0.061
SE(d)		0.661	0.006	0.087
C.V.		1.603	1.874	1.576

NH: Number of seeds /flower head; **SH:** Seed weight / flower head (g); **SW:** Seed weight / plant (g) **Significance at 1% level

are consistent with the observations of Harishkumar *et al.,* (2017) in China aster.

Germination Percentage of Seeds (%):

The germination percentage of F_3 seeds was recorded and statistically analysed, with the results presented in Fig. 3. Among the hybrids, hybrid-7 (*Miraj Local × A.A.C-1*) exhibited the highest germination percentage (85.93%), closely followed by hybrid-8 (*P.G. White × A.A.C-1*) with 83.13%. In contrast, the lowest germination percentage (73.54%) was observed in hybrid-1 (*Arka Poornima × P.G. Purple*).

These results highlight the existence of genetic variability among hybrids for seed germination, which can be exploited in selection programmes aimed at improving seed vigour and field establishment. The present findings are in agreement with the earlier reports of Harishkumar *et al.,* (2017) and Nataraj *et al.,* (2021) in China aster.

Conclusion

The study revealed significant variability among F_3 hybrids of China aster for flower quality and seed parameters, indicating good scope for genetic improvement. Hybrids such as hybrid-10 and hybrid-9 for flower diameter, hybrid-1 and hybrid-2 for stalk length, and hybrid-5 for vase and shelf life performed superior for quality traits. Likewise, hybrid-7 and hybrid-3 excelled in seed yield, while hybrid-7 and hybrid-8 showed higher germination percentage. The findings highlight the potential of these hybrids for both commercial cultivation and as valuable parental lines in future breeding programmes.

Acknowledgments

I would like to express my sincere gratitude to Department of Horticulture, University of Agricultural Sciences, Bangalore for providing the necessary facilities and support that made this research possible. Special thanks to Staff and Students of Department of Horticulture for their assistance with the practical aspects of the research. I sincerely acknowledge the financial support obtained during the study period by Karnataka Science and Technology Promotion Society, Department of Science and Technology, Govt. of Karnataka.

Competing interests: "Authors have declared that no competing interests exist."

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